Spatiotemporal flooding fluctuation analysis: wetland managment Bañado La Estrella, Chaco región, Argentina

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were documented. Results indicate that wetlands area at this Ramsar site decreased from 127526 ha in 1990 to 113705 ha in 2014 at an annual averaged loss rate of 553 ha/yr. The only two vegetated wetland types, *phragmites australis* and *suaeda heteroptera*, have lost 4788 ha and 12856 ha, respectively. Aquaculture ponds increased by 9715 ha, and almost all were transformed from nature wetlands. The landscape metrics used in this study show notable fragmentation of the SERS as a result of the expansion of transportation lands. Multiple human activities occupied large areas of various wetland types. Compared to agricultural reclamation and urbanization, the wetland change at the study site was affected primarily by the development of aquaculture and petroleum industry. Obvious wetland loss and fragmentation determined by the analysis of the Landsat images of the study site suggests that the protection effect has been relatively low in spite of the fact that the SERS is a national nature reserve and Ramsar site. As an internationally critical rest habitat for migration waterfowl, the degradation of the SERS and severe human threats create great challenges for the ecosystem management. This study also indicates that the protection effectiveness of other wetland nature reserves or Ramsar sites should also be assessed using remote sensing to objectively track the conservation or restoration of these areas.

Key words: Remote sensing; human threats; wetland loss; Landscape metrics; Shuangtai Estuary Ramsar site; China

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The wetlands are widely distributed over the Chaco region. Despite their wide territorial extension and major functional role, Bañado la Estella wetlands have not been appropriately mapped, and this is not a protected area nowadays. Wetlands are ecosystems that depend on periodical flooding, which determine the presence of soils with hydromorphic features and species adapted to permanent or temporary flooding conditions.

The bed of the Pilcomayo River began regressing to the west about 30 years ago, creating a wetlands known as the "Bañado la Estrella". We propose an integrated approach, based on satellite imagery analysis (Landsat TM), The NDWI index (Normalized Difference Water) and decision trees, to analyze and characterize seasonal variations (1992-2012) and to map seasonal flooding. We use information about land use and herd distribution (anthropogenic use) and validate it with field data.

Four classes of flooding frequency were defined: permanent flooded areas (80-100 % of the time pixels showed water presence), usually flooded areas (60-100% of the time) and regularly flooded areas (40-60% of the time) during the 1992-2012 period. We are able to delimitate and quantify the total area of Bañado La Estrella wetlands which occupies 1682 km^2 including the permanently, usually and regularly flooded areas. This spatio temporal analysis shows that during the dry period the permanently flooded areas were reduced 462 km^2 of the total wetland area while the usually flooded area occupied 2 % of the total area and the regularly flooded area occupied 5%. Our results suggest that this method can be used to delimitate different zones, gathering together hydrodynamic and anthropogenic activities, in order to be used as tool for the creation of a future protect area in Argentina.

Key words: flooding fluctuations; wetlands management; protect area